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ABSTRACT

The effects of black and white and color illustrations on student achievement were studied to investigate the relationships between cognitive styles and instructional design. Field dependence (FD) and field independence (FI) were chosen as the cognitive style variables. Subjects were 85 freshman students in the Iowa State University Psychology pool. The three major instruments were the Group Embedded Figures Test, a color blindness test, and a computerized pretest and immediate posttest. Treatments were (1) programmed instruction supplemented by detailed, shaded drawings of the human heart in color and use of color drawings to answer posttest questions; (2) same treatment with black and white visuals; and (3) instructional script without visuals. Results showed no significant differences between FD/FI groups and no significant interactions. Posttest mean scores for the two experimental groups did not significantly differ from each other but were significantly higher than those of the control group. Color had minimal effect on posttest scores, and the FD subjects were not adversely affected by the presence of color. The students exposed to instructional materials without visuals needed more time to process and learn information. Sixteen references are listed. (LMM)

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THE RELATIONSHIP OF FIELD DEPENDENT/INDEPENDENT COGNITIVE STYLES, STIMULI VARIABILITY AND TIME FACTOR ON STUDENT ACHIEVEMENT

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Introduction

Concern for the improvement of American education is widely evident today. The National Commission on Excellence in Education (Gardner et al., 1983) stated bluntly that "a tide of mediocrity has devastated public education", and suggested, among other things, that educators must demand the best effort and performance from all students regardless of their backgrounds and orientation.

If educators are to demand the best efforts from all students, we must learn more about cognitive styles. Cognitive styles, especially field dependence/field independence (FD/FI), have recently received much attention, probably because they have been related to many learning abilities and activities. According to Ausburn and Ausburn (1978), almost no research has been conducted on the relationship between cognitive styles and instructional designs. In addition, cognitive styles have not been conceived and studied as a single entity. Rather, a number of different factors or dimensions of cognitive styles have been identified and subjected to systematic theoretical and empirical examination (Ausburn and Ausburn, 1978). Therefore, studies designed to investigate these relationships may be useful to instructional developers and designers.

Related Research

Cognitive Styles

The concept of cognitive style refers to psychological dimensions that represent consistencies in an individual's manner of acquiring and processing information (Ausburn and Ausburn, 1978). Several learning styles have been identified. Each style seems to be related to how the individual processes and learns information. An often studied learning style by

educational technology researchers, because of its relationship to mediated instruction, is field dependence/field independence (FD/FI). Witkin and his collaborators (1971) discussed FD/FI and indicated that the FD person had difficulty locating geometrical figures in a complex pattern. The FI person, on the other hand, did not have such difficulty locating the same figures.

Color Realism and Visualized Instruction

The question of whether color or black and white images have an effect on increasing the performances of an individual has been investigated by several researchers. In summary, a number of studies relating to the color variable, Otto and Askov (1968) concluded that "the cue value of color in learning is still essentially unclear." Rudisill (1952) indicated that students preferred to view colored instructional materials, but Katzman and Nyenhuis (1972) found that color did not improve the learning of materials. Travers, quoted in Kemp (1975 p. 23) concluded that while color adds to the attractiveness of instructional materials, black and white illustrations were just as effective for instructional purposes, except when the learning involved color discrimination.

Realism theories, according to Dwyer (1976), are based on the assumption that learning will be more complete as the number of cues in the learning situation increases. Most instructional materials available today are published in color. An important research question available today may not be whether the presence of color in an illustration promotes learning but whether it may actually deter or hinder learning in a FD or FI student. Does the presence of color make the illustration more complex? Since FD/FI is correlated strongly with one's ability to sift through a series of possible solutions and select the best solution to a problem, in terms of using instructional materials with varying amounts of visual stimuli for

instructional purposes, FD/FI and time on task could affect one's ability to distinguish and organize the relevant cues.

Amount of time and learning

The amount of time used to process information may also interact with cognitive style and stimuli variability to affect learning. Carroll (1963) regarded time as the central variable in school learning, and asserted that students differ in the amount of time they need to learn a given set of materials to some set criterion. Anderson (1973), Arlin (1973), and Ozcelik (1973) studied the amount of time students spend in active learning and found that the amount of time spent on learning were highly predictive of the learning achievement of the students.

Statement of Hypotheses

The following hypotheses were generated and tested at the .05 and .01 levels of confidence:

1. There is no significant difference in posttest scores between FD and FI Ss treated with color, B/W and no illustrations.
2. There is no significant relationship between FD and FI, time on task and posttest scores of Ss in the treatment groups.

Subjects

Eighty-five freshman students in the Iowa State University psychology pool agreed to participate in all aspects of the study. Thirty-eight students of the original 132 who participated in the Group Embedded Figures Test (GEFT) chose not to participate in the total study. In addition, nine students were dropped because of color blindness. Their FD/FI scores were not significantly different from the eighty-five students who completed the study.

Instruments

The major instruments for this study consisted of the GEFT (Witkin et al., 1971), color blindness test (Dvorine, 1953), and a pretest and posttest (Dwyer, 1967) programmed on the Apple II microcomputer. Since the pretest and the posttest were given on the same day, the pretest was created to be more general in nature and would not contaminate the posttest results. The pretest was used solely to establish the uniformity of the entry level of the Ss, and the posttest was used to determine the effects of stimuli variability and time on task. The computer was programmed to display the questions, record the answers and time from initial display until the subject responded to the questions.

Treatment Groups

The treatment groups were established as follows: Group one Ss were treated with programmed instruction supplemented by detailed, shaded drawings of the human heart in color. The subjects also used color drawings of the heart to answer the posttest questions. Group two Ss had the same treatment given to the color group with the only difference that B/W visuals were used instead of color visuals. Group three (control group) Ss were treated with only the instructional script without visuals.

All the subjects answered the pretest (using the computer) before the experimental treatment. Finally, all the Ss were asked to answer the posttest questions using color or B/W visuals and the computer as soon as they finished reading the instructional script.

Data Analysis

The Statistical Package for the Social Sciences (Nie, Hull, Jenkins,

Steinbrenner and Bent, 1975) and the SPSSX (Nie et al., 1983) were used in the analysis of the data. WYLBUR was used to provide on-line interactive text editing capabilities that allow the user to create, change, store and display text. The system also provided services for submitting jobs for batch processing and retrieving the resulting output. The analysis of variance (ANOVA) and Pearson product-moment correlation was used for data analysis.

Results

FD/FI scores were established for each S, and all the Ss were then assigned to FD and FI groups. Ss scoring between 1-11 were classified as FD, and those in the 12-18 range were classified as FI as recommended by Witkin et al. (1971). Because scores were skewed toward FI, that group had a much larger size - 23 FD, and 62 FI Ss.

Pretest scores listed in Table 1, indicated that the cell means were pretty much the same. Analysis of variance (Table 2) enabled the researcher to conclude that no significant differences existed in either rows or columns. It was assumed, therefore, that groups were relatively equal at the start of the experiment.

Posttest scores are listed in Table 3. Analysis of variance (Table 2) indicated that no significant differences appeared between FD/FI groups and that no significant interactions were present. However, significant differences were noted among treatment groups. Further analysis confirmed that the two experimental groups had significantly higher mean posttest scores than the control group. This had been anticipated and is not considered important, since the posttest items dwelled heavily on the visual aspect of the instructional materials. What is important, however, is that the means of the two experimental groups were not significantly different

from each other.

Pearson product-moment correlations are reported in Table 4. The correlations reported reveal that FD/FI and color treatment group had a low positive correlation ($r=0.35$, $p=0.03$).

ANOVA of posttest time by FD/FI with treatment groups (Table 5) also yielded a significant F-ratio ($F=3.60$, Significance of $F = .03$). This indicated that the treatments accounted for the difference in posttest time.

Conclusion

The data on Table 4 indicate that the presence of color in the illustration had minimal effect on posttest scores. These findings are consistent with those of Katzman and Nyenhuis (1972) and Travers (cited in Kemp, 1975). Moreover, there appears to be no evidence to indicate that FD Ss are adversely affected by the presence of color. This is in consonance with the findings reported by Hazib (1979) that no significant difference exists between FD and FI Ss in an experiment using realistic and non-realistic illustrations. The findings also agree with those of Dwyer (1976) that the stimuli variability is not a reliable predictor of learning efficiency. With regards to time on task, it was concluded that students exposed to instructional materials without visuals need more time to process and learn new information.

Important implications concerning the use of color and B/W with Ss possessing different learning styles could be established based partly on the results of this study. Thus, there is need for more experiments to determine whether the other variables in Dwyer's (1967) realism continuum have an effect on cognitive styles. The use of the Apple II microcomputer, as used in the present study, also needs further investigation.

TABLE 1

Cell Means of Pretest scores by Field Dependence/ Field Independence and Treatment Groups

	Color treatment	B/W Treatment	Control
Field Dependence	13.43 (7)	12.20 (10)	13.17 (6)
Field Independence	12.59 (22)	13.16 (19)	13.52 (21)
Group Mean	12.79 (29)	12.83 (29)	13.44 (27)

Field Dependence	=	12.83 (23)
Field Independence	=	13.08 (62)
TOTAL POPULATION	=	13.01 (85)

Table 2

Analysis of Variance of Field Dependence/Field Independence and Posttest Scores in the Three Treatment Groups

Source of Variation	Sums of Squares	DF	Mean Square	F	Significance of F
Main Effects	202.98	3	67.66	3.52	0.02**
FD/FI	13.10	1	13.10	0.68	0.41
Group	195.16	2	97.95	5.08	0.01*
2-Way Interactions	3.17	2	1.58	0.08	0.92
FD/FI Group	3.17	2	1.58	0.08	0.92
Explained	206.15	5	41.23	2.15	0.07
Residual	1517.81	79	19.21		
Total	1723.95	84	20.52		

* Significant at the 0.01 level of Significance

** Significant at the 0.05 level of Significance

TABLE 3

Cell Means of Posttest Scores by Field Dependence/Field Independence and Treatment Groups

	Color Treatment	B/W Treatment	Control
Field Dependence	12.14 (7)	12.20 (10)	9.50 (6)
Field Independence	13.64 (22)	12.95 (19)	9.90 (21)
Group Mean	13.28 (29)	12.69 (29)	9.81 (27)

Field Dependence = 11.48
(23)

Field Independence = 12.16
(62)

TOTAL POPULATION = 11.98
(85)

TABLE 4

Pearson Correlation Coefficients of Field Dependence/Field Independence and Achievement (Posttest Scores)

GROUP	SCORE
Color Treatment FD/FI	0.35 p=0.03
Black and White Treatment FD/FI	0.21 p=0.13
Control FD/FI	0.07 p=0.37

TABLE 5

Analysis of Variance of 2-way interactions of Posttest Time with Field Dependence/Field Independence and treatment groups

Source of Variation	Sums of Squares	DF	Mean Square	F	Significance of F
MAIN EFFECTS	20358.01	3	6786.00	2.63	0.06
FDFI	2080.08	1	2080.08	0.81	0.37
GROUP	18591.94	2	9295.97	3.60	0.03*
2-WAY INTERACTIONS	8943.48	2	4471.74	1.73	0.18
FD/FI GROUP	8943.48	2	4471.74	1.73	0.18
EXPLAINED	29301.50	5	5860.30	2.27	0.06
RESIDUAL	203784.69	79	2579.55		
TOTAL	233086.19	84	2774.84		

*Significant at the .05 level

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